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ABSTRACT

This paper explores questions associated with chaos theory as it relates to problems in the arts. It reviews the work of several scholars including Minai, Eckersley, Pickover, the Kirsches, and the Molnars. The document directs special attention toward three basic areas in art and design education, which are: (1) the integration of the computer into the practice of the fine arts (as separate from computer assisted design) as a conceptual and a creative tool; (2) the implications of chaos theory for design and aesthetic theory; and (3) the challenge of chaos theory for modern and post modern movements in art and design. The paper concludes with some remarks about the nature of randomness and the relationship of order and chaos in design theory. It concludes with observations about the limitations of present theory of the elements and principles of design. It attempts to apply elements of the three disciplines of cognitive psychology, Gestalt theory, and computer science to educational as well as artistic problems in areas of art and design education. (Contains 18 references.) (Author/SG)

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CHAOS THEORY IN THE ARTS AND DESIGN

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ABSTRACT

This paper shall explore questions associated with chaos theory as related to problems in the arts. It will review the work of several scholars including, Minai (1989), Eckersley (1990), Pickover (1990), The Kirsches (1989), and The Molnars (1989). Special attention will be directed towards three basic areas in art and design education which are:

(a) the integration of the computer into the practice of the fine arts (as separate from computer assisted design) as both a conceptual as well as a creative tool.

(b) the implications of chaos theory for design and aesthetic theory.

(c) the challenge of chaos theory for modern and post modern movements in art and design.

The paper will conclude with some remarks about the nature of randomness and relationship of order and chaos in design theory. It will conclude with observations about the limitations of present theory of the elements and the principles of design.

It attempts to apply elements of three disciplines; cognitive psychology, Gestalt theory, and computer science to educational as well as artistic problems in areas of art and design education.

INTRODUCTION

Since the establishment of an art and design school called "The German Bauhaus" in 1923, the idea that there is a formal design language based on the elements and principles of design, has become one of the primary sources of context for education in the arts. The basic approach of the Bauhaus was an attempt at applications to art education of the research in perception as practice by the early Gesalt psychologist (Arnheim, 1954) It seems to this writer that new conceptions of the nature of randomness may cause one to question the nature and scope of theories of art and designs which are based on the elements and principles approach and upon an aesthetic theory which itself has based upon formalism. (Jenes 1991).

Many of the observations, as well as the general idea for this essay, grew out of an honors seminar on the general topic of the golden section and the uses of dynamic symmetry in art and design. That class probably represented the first time that books by Cook (1911), Huntley (1968), and Hambidge (1968) have been used as basic texts for a college course for some years. (The students in the seminar consisted of five architecture students and four from a variety of scientific fields who took the course as a three credit general honors elective to fulfil a general studies requirement in the humanities and the fine arts.) The Golden section is an aesthetic theory which can be traced to ancient Greek mathematics and to the geometry of Euclid. It is a principle which describes many of the more recent discoveries within science. The theory of dynamic symmetry was an idea re-discovered by Jay Hambidge, an American artist who lived and worked in the first two decades of this century. The search for a natural theory of design was an important idea in the first two decades of this century but was replaced by the ideas which had been developed at the Bauhaus.

One of the first problems addressed in the seminar was the nature of chaos and the emergent interest in chaos theory which seemed to abound in at least the more popular scientific press. The writer James Gleich (1989), among others; has observed that explorations into chaos theory have

reversed the more traditional format of the scientific method and the scientific inquiry in general. Rather then proposing solutions to clearly defined problems or experimental hypotheses, chaos as theory and as science, presents a solution leaving the researcher to search from the specific problem which fits the data or the pattern of data produced by various explorations into universal questions. In the arts chaos theory has manifested itself in the use of random patterns, an interested in symmetrical and non-symmetrical systems, the applications of computer generated imagery, the possibility through inter-active video disks to re-cycle art from the past, and the development, of visual images from mathematical formulas. All of these new directions seem to cast serious doubts about the nature of aesthetic theory and artistic practice that has been based upon "Ideas of perception and the elements and principles of design."

Minai writing on the nature of architecture and aesthetic communication has offered the following relevant observations for our general theme and for the beginning of this paper. He wrote as follows:

> *"The characteristics of the proposed creative measures encompassed in human experience and resulting environmental forms are considered to be order-disorder." This approach to the design of an aesthetic environment is based on the assumption that within the seeming randomness of life is an order (order-disorder) that is more meaningful than order imposed by formal rationality." (Minai, 1989)*

The aesthetic for Minai is not an allusion to historical artistic styles but rather it signifies a wider definition, a unified framework for integrating all human endeavors involved in measuring, tracing, and/or documenting the person-cosmos relationship; this for Minai is called communication and is used to refer to the qualitative structures by which information is exchanged. This can be best described in Whitehead terms as a phenomena which is not linear, undirectional, but rather a feedback mechanism that transforms order into chaos; disorder into order in a process which Minai has described as "biological information". The formal rationality of which Minai writes in the above is of the major characteristics of formalistic aesthetic theory.

At the essence and the center of chaos theory is the idea that a rather large chunk of life, the cosmos, itself constructed from many overlays of complexity; of states of transformation from one configuration to another; from order to disorder; and from disorder back again to order. It is in modern computer technology a feedback loop; a mechanism by which change becomes cyclical not linear.

The value of the idea of a feedback loop was put forth as a part of some of the observations that Eckersley and McWhinnie (1989) made in a letter to the editor of Leonardo (a journal devoted to the inter-relationships of Technology, art, and science) concerning ideas by Alexander Vitkine.

In his article, "Photographic and Electronically Generated Images", (LEONARDO, V 19, nl,) Alexander Vitkine presented views concerning the role of graphic images, introduced the reader to his images, and described in some detail the process he has developed to create them. Vitkine asserted, essentially, that graphic images are comprised of distinguishable essential and non-essential information, and that they function to relay information to the viewer. He maintained that the presence of non-essential information in a work of graphic art detracts from and compromises the value of the work, and that only when purged of the non-essential information; can the graphic work be purely and intensely perceived by the viewer. Consistent with formalistic aesthetic theory it was Vitkine's point of view that the role of the arts and design was to make order out of chaos and not to recognize order in chaos.

Eckersley and McWhinnie made the following critique of the Vitkine article from Leonardo:

"Our response to Vitkine centers around the casualness with which he cites scientific findings to validate his arguments, as well as with the questionable artistic significance of his images themselves. Specifically, our response was necessitated by the following questions that came to mind upon reading the article: (1) On what basis and using what criteria can one distinguish between essential and non-essential information in graphic image? (2) Can elaborative graphic information (decorative elements) be presumed appropriate to be non-essential to the graphic image? (3) Does a graphic image, shed of non-essential information therefore possess aesthetic and/or creative value? (4) If, (as Vitkine asserts) the primary role of the graphic image is to relay

information, to a receiving/perceiving human public; to what degree is the artist responsible for making the information perceptually and conceptually engaging? (5) Does the novelty of a generative process (such as Vitkine's electronic method) somehow ensure the creative and aesthetic value of the image, or can it easily divert attention from the weakness of the image itself?"

It seems reasonable that any discussion of what is or what is not an essential part of a graphic work, must first entertain the notions of content and significant form. Without such a content foundation, any form of communication (visual or verbal), structured formally or informally, falls apart and fails to engage prolonged attention. The issue of content (i.e., underlying ideas or concepts) and its role in graphic communication is something Vitkine failed to attend to in his article. In fact, what distinguishes his photographic works from his electrically generated works is not the factor of originality, as he suggests, but rather the content information embedded in the photographs. In the photographic works, communication has been ensured by the camera's recording of an understandable and visually engaging event. But in the electronically generated images, no such reference is present. The perceptual search is terminated in the viewer, not by his/her recognition of an event (as in the photographs); but rather by a sense of frustration caused by the lack of such recognition.

Vitkine forwards the notion of a direct relationship between the quickness and completeness with which an image can be apprehended by a viewer, and its aesthetic importance. Certainly, the logic behind such an aesthetic is evident in the field of applied visual communication. For that reason our critical signage systems rely, for instinct, on a bold Helvetica typeface rather than a stylized script. However, in fine art, the issue of easy and direct understanding of graphic images is not so critically important. What is critical, however, is that a visual artist have something interesting to communicate and do so effectively by graphic means. It can be argued that the work of many notable artists has relied on the use of embellishment and decoration. Of central concern, therefore, is not the quickness with which perceptual closure occurs within the viewer, but rather the prolongation of the viewer's attention. Indeed, one might conclude that the longer an artwork functions to engage an audience, by whatever means, the greater its significance.

Vitkine is simply uninformed in his implication that human beings need or desire quick perceptual closure of graphic images in all circumstances. It should be remembered that human beings have a natural tendency to seek visual complexity as well as it's reduction (Gibson, 1969). In experimental psychological work, such as that done by Hunt (1963) and others, it has been shown that human beings as well as primates seek stimulation that offers an "optimum amount of novelty, surprisingness, complexity, or change". Although the threshold for such stimulation naturally tapers off when such stimuli reach excessive levels; artists and designers should not presume that viewers need to desire immediate closure in all situations and for all communications. Where extreme spareness may be appropriate in the design of a signage system, it is probably unnecessary (on the basis of our knowledge of human perceptual behavior) in a work of art or design where the factor of time is not so pressing, and where viewers are actually seeking perceptual stimulation.

Eckersley (1990), Kirsch (1989), as well as Minai; have all observed that while order has been identified with aesthetic qualities, throughout the ages and with the nature of good in works of art; the more recent evidence shows that disorder has also had a significant role to play in what one might choose to describe as "good design". For L. L. Whyte (1960) order and disorder are two sides of a coin, both essential for what can best be described as complexity. For Schrondinger order and disorder are not opposing contradictions but randomness; best described as a tool of increasing order. For Jean Baudrillard, our world is virtually one of randomly interacting signifiers, messages, images, and representations. This cross section of observations about the order-disorder continum is a fair sampling of opinion from the arts as well as the sciences and seems to confirm the observations of Minai in reference to aesthetic environments and architecture and further lead to a general questioning of the Vitkine thesis of order and simplicity.

THE UNITY OF THE OPPOSITES

The old gestalt principle of unity-in-variety can be re-stated in probabilistic terms and those relationships can be expressed in terms of statistical relationships. In aesthetic terms, to have a richer composition or pattern requires more variety and more originality. However originality needs to be measured against some similarity. For example, the high probability of Similarities (background) and the low probability of occurrences or uniqueness of dissimilar entities (foreground) are complimentary one to another.

Minai concludes his observations with the following:

> *"Chance is accepted to play a fundamental role in the functioning of the universe. Aesthetic communication encompassing the overall experience of man could be a play field of predictable and unpredictable probabilities or chance and necessities built into circumstantial entropies potentially capable of moving in all directions." (Minai, 1989)*

CHAOS THEORY AND DESIGN STYLES

If the phrase "less is more" seemed to characterize the work of the modern movement as it passed into the mid 1960's, a logical conclusion to basic of Bauhaus ideology; then "less is a bore" seemed to characterize the transition from moderism to post-moderism. Was is accidental that the basic roots of chaos theory and the final dissolution of the modern movement occurred in the mid 1960's? If we are consistent with Minai's observations quoted earlier; post modernism should not be viewed within the context of a succession of design styles in a linear format, post modernism is a circular process. As then a non-linear model, consistent with some of the ideas of chaos theory; it seems to be a better explanation for the change process in design style. In this sense we are using chaos theory more as a metaphor then a set of exact laws. If artists and designers were surprised and overtaken with so many new ideas as a consequence of "the fall of the modern

movement", it may be because they had failed to note the various sources of aesthetic noise (in the sense of chaos theory) which had accompanied the modern movement throughout it's long development.

Most probably the aesthetic theory which best suited the modern movement and the work of the Bauhaus, at least in it's early history; was the doctrine of "art as significant form." (Bell, 1913) The theory implied that there was a structure to art, a structure which could be identified by perceptual and formal analysis. (McWhinnie, 1970) For a formalist, the work of art or piece of design was anything but random; it's form was a consequence of a visual language, the elements and the principles of design schools of the day (in addition to the Bauhaus), such a theory posted the idea that the work of art was a consequence of an highly conceptual as well as a perceptual formal language which had a structure, a logic, and a syntax of its own very much like verbal language. This idea became a cornerstone for formalistic theory but earlier efforts by Hambidge, Cook, Thomson and others to relate design principles to natural laws rather then to abstract formulations were a part of what one may wish to describe as a "hidden stream" and so such it was ready to surface once more as a part of general concerns over chaos theory.

QUESTIONS OF SYMMETRY AND COMPUTER ART

This paper will conclude with the research in the general area of symmetry, computer art, and randomness. It will feature the creative research of:

Vera and Francois Molnar
Russell and Joan Kirsch
Michael Eckersley

The computer based art and design products of three artists will be discussed relative to basic theory and the history of studies in symmetry, randomness, and aesthetics. Their respective explorations into the domain of computer based art and design will be discussed in terms of a general theory of symmetry in art and science.

Vera Molnar has over the past few years explored variables of randomness in the visual arts. The advent of sophisticated computer based systems for art and design graphics has enabled the artist, as well as the scientist, to explore more deeply questions of symmetry and randomness in matters of art and design. Randomness has often been confused, at least in the minds of the art critic and some aestheticians; as being associated with chaos and disorder. However randomness has been more recently shown to be a viable approach to the use of the computer in various forms of artistic expression.(Molnar, 1989) In one sense randomness, the development of endless patterns, shapes, and forms from mathematical formulas, demonstrates that there is a system of order; order which can be made visible, be made apparent, even in the use of random methods with the computer as a tool. Molnar has observed (Molnar, 1979) that the choice of elements in a painter's work seems to be arbitrary, every painters' selection is a function of their artistic taste, of their temperament, of their field of interest or school to which they are affiliated. Molnar chose to make her art out of the purest of abstract forms, simple and regular geometric shapes, privileged forms having qualities necessary for the building up of valid visual artistic expressions. Her choices were however the result of her subjective taste, the plastic strength of geometry, her love of the rational purity of mathematics rather then any pure formal qualities which existed outside of her experiences as an artist.

When the initial selection of the forms has been achieved, what are the assembly rules, the artistic procedures which the artist follows? One can according to Molnar proceed as follows:
(Molnar 1986)

(a) follow the classical rules of composition and Rules of Order;; (the golden section as well as other principles)

(b) reject all rules, look for new structures in chaos;

(c) achieve a new synthesis of rules and no rules which is part of her view of the random qualities which can be added to the work. Synthesis of order and disorder.

What random systems seem to offer the artist/designer is the opportunity to achieve in that new synthesis of rules and no rules, a higher order; a higher level of symmetry.

For Molnar the artistic problem becomes a question of how to organize forms and colors in a way that we have not seen before. Here is where computers and computer graphics systems can make the task of the artist easier. As a tool the computer can model and present to the artist possible virtual pictures. For Molnar the problem becomes one of sampling and she proposed a system of ordered samples; random samples of all of the possible or virtual realities of art and design solutions that were possible within the forms that her programs were creating. She also used a criteria for the selection of her random samples based upon the cannons of classical art. (In other words the synthesis which she sought between the old and the new?)

In addition to questions of pattern recognition the Molnars have explored questions of symmetry vs. non-symmetry in both scientific and artistic research. (Molnar and Molnar, 1986).The Molnar's have observed in almost all of their work that symmetry has always been regarded as an important factor in visual aesthetics. But perceptual symmetry is not always identical to the symmetry as defined by mathematics. A symmetrical picture (in the artistic sense) is not always symmetrical in the mathematical sense. For the Molnars, the concept of form, in the broadest sense of the word, is reduced by the computer scientist to a lack of randomness within an organized set of design elements. In this way, the property of form is a negative one, the delineation of features of form that distinguish forms from randomness, or noise.

In Molnar's view there are only a few instances in which pattern-recognition is treated as a human problem. Almost all recent research, such as that of Russell Kirsch, is directed towards algorithms which detect patterns instead of towards mechanisms which explain how the human sensory system detects patterns. For Molnar the detection of patterns seems to be at the very core of the aesthetic response. There are some interesting personal similarities between the Kirsches and the Molnars. We have two husband-wife teams working in tandem on questions in art and science. Russell Kirsch is a computer scientist and a specialists in artificial intelligence; whereas his wife is an artist and a museum educator. Both the Molnars and the Kirsches make use of the computer and explore questions of order and disorder within the confines of chaos theory. They are working on a similar problem, the detection of patterns but approach the question from different points of view. Both seem to challenge the basic theory of Vitkine and question the aesthetic basis of the modern movement in a manner similar to that of Ron Jones (1991).

In a recent Leonardo article (vol. 22, no. 1, pp 15-20, 1989) the Molnars continued with the explorations of questions of form, of randomness, of noise and art. In that article their conception of form was related to both perception and to art, and art is viewed as one of the more exciting conceptions created by human consciousness. This ancient topic has received a new idea from the research on the automated recognition of form, and area that has been closely related to questions of artificial intelligence. In their view, this new branch of research often neglects the human aspect of the problem; the capacity of the human being as a basic receptor.

Russell and Joan Kirsch (Leonardo Vol 21, No 4 pp 437-444, 1988) on the other hand have also used the capacity of the computer view paintings, to make a variety of decisions. In a sense they have followed up upon this same line of inquiry but to have worked quite independent of the knowledge of what the Molnars were doing in Paris. The Kirsches asked the computer to "look at" works by Miro and Diebenkorn in terms of the rules or grammars of design employed by both artists in their work. Molnar has observed the following about the perception of symmetry as a

part of human information processing; he wrote:

"In spite of at least a century of intensive research, psychologists are still unable to link the level of perceived symmetry to the physical elements of a picture. In a statistical processing of a picture, the skewness of a one-dimensional distribution can be measured, but skewness means degrees of deviation from symmetry. So skewness measures asymmetry." (Molnar 1989, pp 292)

Symmetry is one of the more indistinct of conceptions in the artistic vocabulary. For Vitruvius, symmetry consisted in the agreement of the measure between the distinct elements and the whole, which for many became a definition of the golden section. The relationships of mean and extreme ratios. For the Molnars and others, the use of the computer, creation of randomness, can produce patterns that are aesthetically pleasing, but are not examples of a mathematically defined symmetry and yet are perceived to have some of those aesthetic elements, values of order, balance, and above all proportion which one defines as begin symmetrical.

The basic strategy used by the Kirsches in their research was to prepare a set of algorithms based on the design principles and creative strategies both artists seemed to employ in their work. They had the computer analyze various random patterns and configurations that had been based on the pre-selected grammars of design composition. In a sense they had their computer create or re-create new Miros or Diebenkorns according to the grammars used. They tested their results by having the artist Diebenkorn view the solutions. He confirmed that several of the computer's creations resembled recent works of his own.

Michael Eckersley of the Design Department of the University of Maryland has explored a variation on the Molnar method. His algorithms are much looser then Kirsches, he employs almost no formal analysis. A recent paper in Leonardo Fall (1989) by Erasure has examined his conceptions of randomness and chaos as they impinge upon the creative study and practice of design. He has created a body of original work which has involved the transportation of computer-generated random number streams into usually fascinating and thought provoking graphical concepts. A

natural evolution of Eckersley's more recent work (1990) was to create computer based performs that he has called, "the design helper." Students use these program to complete images and patterns that can be related to specific design questions.

The editor of Micro Cad News (Vol 5, No 3 April 1990) observed as follows on the topic of chaos: "It is the fault of my readers to have believed that dealing with chaos in my work and personal life was an art. Instead, I have found it to be a science." "The science of chaos doesn't explore a problem in order to come to a solution. Rather it explores a solution and then questions what problem it has solved." We may have come up with the answer to the cosmic question but now we need to generate something for more difficult, generate the cosmic question for which has formed the answer. To some extent this describes the role of the design helper.

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